



Preventing Indoor Air Quality Problems In Schools During Construction And Renovation

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Preventing Indoor Air Quality Problems In Schools During Construction And Renovation

- New Site Construction
- Additions to Existing Campus
- Renovation



Preventing Indoor Air Quality Problems In Schools During Construction And Renovation

- Introduction to Indoor Air Quality
- Design and Construction Considerations



Introduction to Indoor Air Quality

Indoor contaminants can derive from the outdoors, from sources in the building structure or the HVAC system, from the operation and maintenance of the building and its equipment, from the building contents, or from the building occupants or their activities.

Contaminants can migrate horizontally or vertically within the building. There are a large number common contaminant sources that need to be recognized, measured, and often controlled during the design and construction process



Introduction to Indoor Air Quality

Major Changes

1. In the past 5 years IAQ management has shifted from engineering to safety and health.
2. This shift requires that managers broaden their approach from one that emphasized "Standards" to one that includes the concept of "Standard of Care."



Introduction to Indoor Air Quality

Standard of Care

1. Standard of Care is best described in terms of reasonableness.
2. What constitutes a reasonable action on the part of the IAQ manager?
3. What would another knowledgeable person have done when faced with a similar complaint or problem?



Introduction to Indoor Air Quality

Knowledgeable Person

1. Should your company put an individual in charge of their IAQ program who does not qualify as a knowledgeable person?
2. How do you demonstrate that you do qualify as knowledgeable IAQ manager?



Introduction to Indoor Air Quality

Investigation and Remediation

- Interview other Occupants
- Investigate the HVAC System
- Determine Pollutant Pathways
- Locate Contaminant Sources
- Start Source Control Procedures
- Increase Ventilation in Event Area
- Evaluate Filtration and Adjust as Required

*The above steps **MUST** be performed by a
"Knowledgeable Person"*



Introduction to Indoor Air Quality

Source Control

1. Removal
2. Substitution
3. Changes in Design or Operation
4. Encapsulation
5. Spatial Confinement
6. Temporal Use
7. Ventilation
8. Air Cleaning



Introduction to Indoor Air Quality

Environmental Stressors

- Temperature, Relative Humidity, Light and Noise
- Air speed (drafts)
- Lack of daylight
- Glare
- Solar heat load
- Electromagnetic fields (EMF)
- Ergonomics



Introduction to Indoor Air Quality

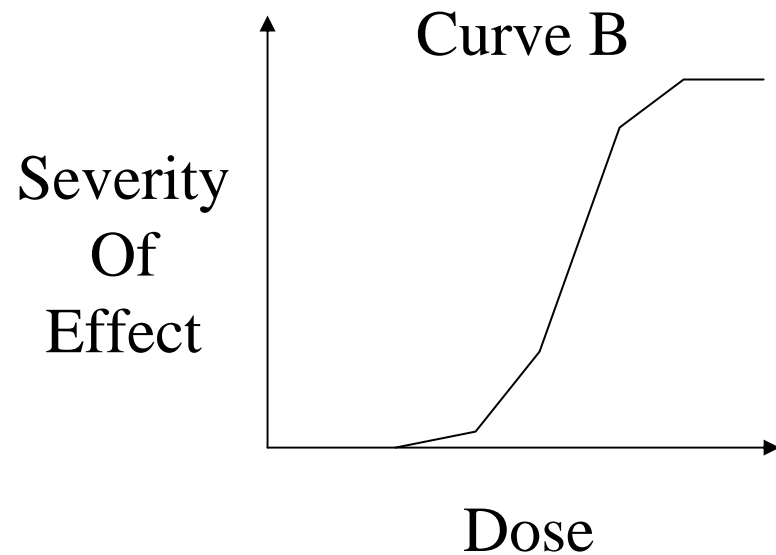
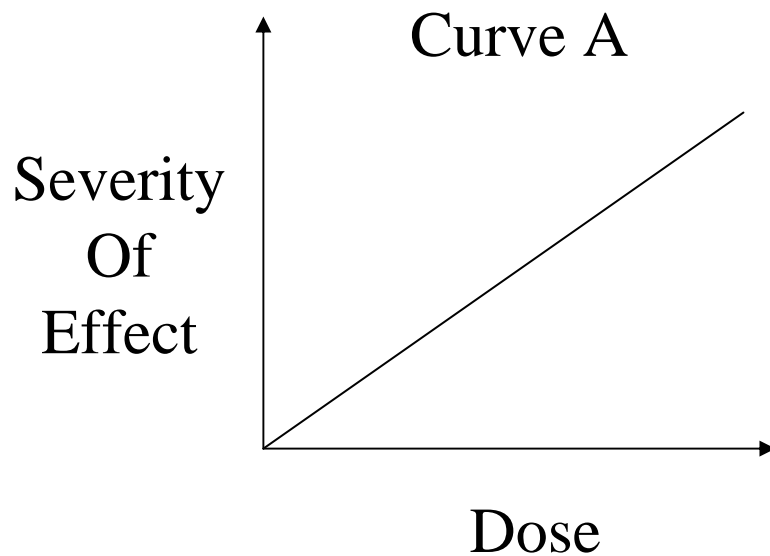
Emerging Concerns

1. Contaminant Mixtures
2. Building Related Illness
3. Sick Building Syndrome
4. Mass Psychogenic Illness
5. Multiple Chemical Sensitivity



Introduction to Indoor Air Quality

Dose-Effect Relationship





Introduction to Indoor Air Quality

Children are More Susceptible

- Children breathe a greater volume of air relative to their body weight and therefore the same concentration of pollutant results in higher body burdens in children than in adults.
- Children are less resistant to infections as their immune systems are still under development.
- Kindergarten and elementary school children spend much of the time occupied at floor level and thus their predominant "breathing zone" is much closer to floor level than is adults.
- These children are closer to the dust and dirt normally present on floors and carpets and are more likely to inhale and ingest dirt, dust, bacteria and fungi, from fingers and objects.



Introduction to Indoor Air Quality

Cause for Action

Liability cases make effective management of indoor air quality essential



Introduction to Indoor Air Quality

Basic Principles of Tort Law

Duty: The legal obligation to protect another from harm.

Breach: Failure to conform to a reasonable **Standard of Care**.

Causation: The breach must be the proximate cause of some injury.

Damages: The claimant must prove that some damage resulted from the negligence.



Introduction to Indoor Air Quality

Contamination from Indoor Sources

- Microbial growth
- Fibers from torn interior insulation in the HVAC system
- Improper use of biocides, pesticides, and cleaning products
- Dust, dirt, VOC emissions, and noise from construction
- Improper venting of combustion products
- Volatile organic compounds (VOCs) emitted from interior finishes, furnishings, textile finishes and consumer products
- Ozone and VOCs emitted from office equipment such as printers and photocopiers
- Emissions from special use areas such as kitchens, toilets, labs, vocational arts processes, cafeterias, etc.
- Carbon dioxide generated by occupants
- Occupants' body odor and perfumes
- Occupants' illnesses



Introduction to Indoor Air Quality

Contamination from Outdoor Sources

- Pollen, dust, fungal spores
- Industrial pollutants
- Ozone
- Vehicle exhaust
- Odors from dumpsters
- Contaminated cooling tower drift
- Dust from construction
- Re-entrainment of building exhaust
- Radon gas in soil
- Soil contaminants from previous uses
- Pesticides in soil



Introduction to Indoor Air Quality

Source Identification

- *Building Equipment*
 - HVAC systems are increasingly recognized as sources of pollutants
 - Microbial contamination of filters is a potential source of microbes and their metabolic by-products



Introduction to Indoor Air Quality

Source Identification

- *Occupant Activities*
 - The most important source, and the one over which building designers and constructors have the least control is the building occupants themselves
 - The nature of the occupants and use of the building space are important design considerations



Introduction to Indoor Air Quality

Source Identification

- *Load Documentation and Calculations*
 - Both thermal and pollutant loads should be documented and considered part of the design process as well as the building management process
- *Outdoor Air Ventilation*
 - Adequate outdoor air supply involves assessing the quality of the outdoor air as well as the needs to remove pollutants
 - Starting up HVAC systems too late in the morning or not providing enough ventilation can contribute to IAQ problems



Design and Construction Considerations

Overall Design

- Design for the whole person:
 - The human body and mind integrate all the factors in the physical, chemical, biological, and psychosocial environment
- The more satisfied building users are, the longer the building will remain in service, avoiding the need for additional demolition or construction



Design and Construction Considerations

- A school building is a dynamic entity with often-changing pollutant, heating and cooling loads. *Healthy Buildings International, Inc.*
- The Building System Approach should be applied at the design stage and continued through construction, commissioning, operator training, and on-going building operation and maintenance.
- The common goal should be to ensure the health and comfort of building occupants over the life of the building.



Design and Construction Considerations

- The design team must make appropriate assumptions about the use of the building
- Operational schedules must be adequate to remove pollutants accumulated during construction
- When maintenance or housekeeping involve the application of chemicals, adequate time should be scheduled to insure emissions are removed before re-occupancy



Design and Construction Considerations

Requires adherence to the following standards and guidelines

- ASHRAE Standard 62 (for ventilation)
- ASHRAE Standard 55 (for comfort/environmental stress)
- ASHRAE Standard 52 (for filtration)
- ASHRAE Guideline 1P (for commissioning)

A working knowledge of these standards and guidelines will help insure the benefits of prevention over cure in treating building system ailments.

Such foresight also sets the foundation for a permanently healthy building and lessens the chances of problems later during its occupied life.



Design and Construction Considerations

Reducing Energy Consumption

- effective building envelope insulation
- tightly-sealed openings
- control of air movement and thermal transport mechanisms
- **This does not mean minimal ventilation**



Design and Construction Considerations

A five-step approach to reducing exposure to VOC's

- Evaluate and select low-VOC-impact building materials and products
- Pre-condition certain materials to minimize VOC emissions after installation
- Install building materials and products based on their VOC emission decay rates
- Ventilate a building during and after installation of new materials and products
- Delay occupancy until VOC concentrations have been reduced adequately



Design and Construction Considerations

VOC Emission Decay Rates

- Phased installation of building materials and products based on their emission and adsorption characteristics
- **Wet** products such as paints, adhesives, and taping and deck leveling compounds should be installed first
- Porous materials, such as carpets and fabric-covered office dividers, should be installed last



Design and Construction Considerations

Pre-condition certain materials

- Conditioning of materials with appropriate ventilation in a dry, well-ventilated area other than the one where the materials will be installed
 - Examples; furniture and carpeting
- There is little data demonstrating the minimum length of time needed pre-condition building products



Design and Construction Considerations

Ventilation System Design and Operation

- Local exhaust
- Air distribution strategy and ventilation effectiveness
- Outdoor air ventilation rate
- Accessibility of all system components
- Operator training
- Commissioning



Design and Construction Considerations

HVAC Commissioning

- HVAC commissioning ensures, through proper documentation and verification, that the performance of an HVAC system meets design parameters.
- HVAC commissioning helps reduce indoor VOC concentrations by ensuring that the proper amount of ventilation is supplied into a building.
- HVAC commissioning also improves thermal comfort and reduces energy consumption.



Design and Construction Considerations

- A major cause of indoor air quality problems is premature occupancy
- This requires planning from the outset for adequate time between scheduled completion and initial occupancy



Design and Construction Considerations

Modification and Renovation

- During construction activities, construction dust, fumes, and vapors must be contained
- Temporary ventilation and isolation barriers should be employed



Design and Construction Considerations

Maintenance and Housekeeping

- Neglected or deferred maintenance is often the source of IAQ problems
- Design should provide for access to all components of HVAC systems for inspection, repair, and cleaning



Design and Construction Considerations

Building Flush Out

Recommended duration for building flush-outs is to flush-out as long as economically feasible, but not less than continuously (i.e., 24 hr) for seven days



Design and Construction Considerations

Composite wood products

- Specify low-formaldehyde-emitting products meeting HUD, HPVA, and NPA's guidelines
- When possible, consider completely sealing or encapsulating all exposed surfaces, including any penetrations, to minimize emissions
- Note that VOC-emitting wood preservatives may be used in some of these products.



Design and Construction Considerations

Treated wood

- If treated wood comes in contact with indoor air, seal or encapsulate exposed surfaces
- Wood treated with pentachlorophenol (PCP), an eye, nose, throat, and skin irritant should not be used inside buildings



Design and Construction Considerations

Gypsum wallboard

- Paper covering on both sides of gypsum wallboard may contain chemicals from previous uses
- VOC emissions from gypsum wallboard can be reduced considerably, but not eliminated, by painting or laminating the surfaces



Design and Construction Considerations

Wall coverings

- Fabrics, plastics, and paper wall coverings have potential for VOC emissions
- Adhesives and backings are also important components of wall-covering assemblies
- Only the minimal amount of adhesive that meets the installation criteria should be used



Design and Construction Considerations

Wood flooring

- Hardwood flooring is an attractive option from an indoor-air-quality perspective if it is installed with mechanical fastening (i.e., is nailed down)
- Floating pre-finished floors are best for IAQ



Design and Construction Considerations

Adhesives, Sealants, and Caulks

- Specify application of only the minimum amounts of these materials necessary for satisfactory completion of each installation task.
- Require that adhesives have the lowest possible content of toxic or irritating VOC's while meeting other performance requirements.
- Require that the manufacturers of adhesives, sealants, and caulks submit results of emission tests as well as drying times for each product.
- Ensure that maximum ventilation is supplied during and after application of these products



Design and Construction Considerations

Paints

- Minimize the use of solvent-based paints indoors.
- Do not use any coating indoors that is intended for exterior use.
- Ensure that maximum ventilation is supplied during and after application of paints



Design and Construction Considerations

Reducing Carpet Emissions

- Specify carpets having CRI's indoor air quality label
- Carpet emissions accelerate with increased temperature
- Carpet emissions do not accelerate with increased air movement and ventilation



Design and Construction Considerations

Building Bake-Outs

- The purpose of a **bake-out** is to "artificially age" building materials and products by accelerating emissions of residual solvents
- A building bake-out involves elevating the temperature of an unoccupied, newly constructed or remodeled building to between 95 and 102 degrees



Links to Useful IAQ-related Web Sites

- Environmental Protection Agency Indoor Air Quality Home Page
Tools for Schools
<http://www.epa.gov/iaq>
- Occupational Safety & Health Administration
<http://www.osha.gov/>
- Department of Education
<http://www.ed.gov/>
- National Institutes of Health
<http://www.nih.gov/>
- American Industrial Hygiene Association
<http://www.aiha.org/>
- Division of Environmental and Occupational Disease Control
<http://www.cal-iaq.org/Usefulst.htm>